

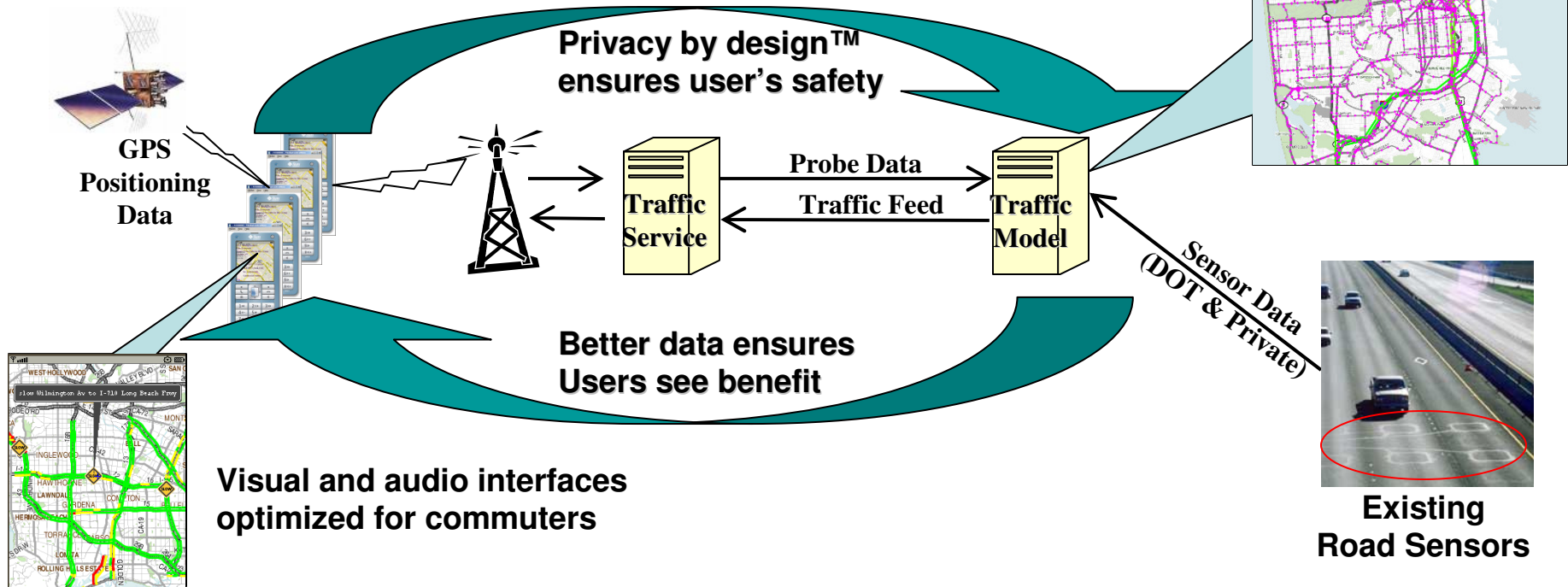
Mobile Millennium

Community-Enhanced Traffic Technology

Quinn Jacobson

GPS measurements of local conditions
optimized for efficiency & privacy

Innovative traffic models for
Highway and arterial roads



Large California Pilot Starting November 2008

NOKIA
Connecting People

NAVTEQ



ET California Center
for Innovative Transportation



Public / Private / Academic Partnership

Departments of Transportation

- California DOT, Federal DOT
- Provides practical needs and application
- Provides validation of the relevance of the research

Industry

- Nokia, Navteq
- Provides implementation expertise and systems knowledge
- Provides future path to market

Academia

- UC Berkeley, USC, Rutgers University
- Provides the scientific and field expertise
- Provides the institutional framework to perform research



NAVTEQ

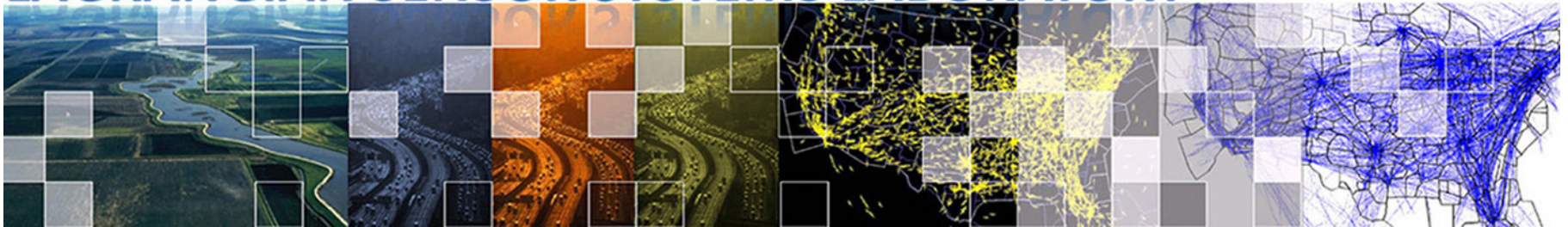


Host institutions (UC Berkeley)



*The California Center for Innovative Transportation (CCIT) **accelerates** the **implementation of research** results and the **deployment of technical solutions by practitioners** to enable a safer, cleaner and more efficient surface transportation system.*

LAGRANGIAN SENSOR SYSTEMS LABORATORY



The Lagrangian Sensor Systems Laboratory focuses on the development of algorithms and technology for mobile sensing, in particular for transportation and water distribution systems.



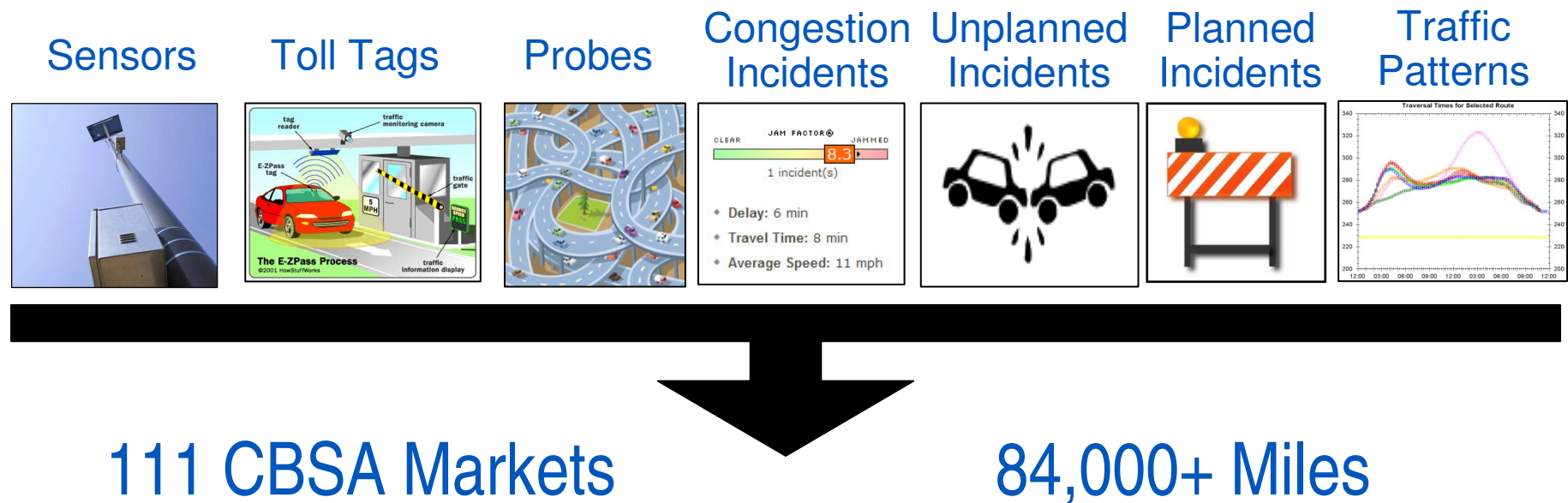
Private Partners

- NAVTEQ Traffic powers the leading traffic-enabled navigation solutions in North America
 - #1 Vehicle Navigation System and the Top 9 ranked in-vehicle traffic-enabled navigation systems
 - #1 Wireless Navigation Service – VZ Navigator.
 - #1 Portable Navigation Device manufacturer – Garmin
 - #1 U.S. traffic-only website for online and mobile traffic
- Nokia is the world leader in Mobility
 - Driving the transformation and growth of the converged internet and communication industries



Hierarchical Travel Time Model offers broad coverage

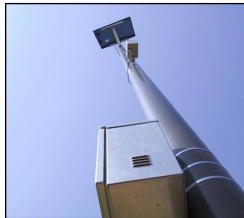
HTTM (Hierarchical Travel-Time Model) factors in various real-time traffic sources such as **Sensors**, **Toll-Tags**, **Probe Vehicles**, **Congestion Incidents**, **Generic Incidents**, and **Traffic Patterns**. This results in **84,000+ miles** of Real-Time Traffic Coverage across **111 CBSA** (Core Based Statistical Area) markets.



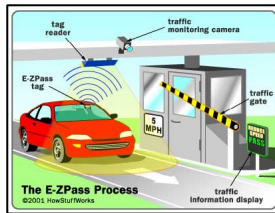
HTTM Real-Time Traffic

Hierarchical Travel Time Model Data Sources

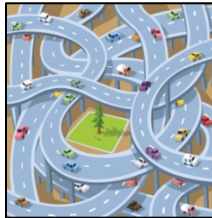
Sensors



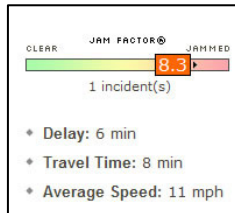
Toll Tags



Probes



Congestion Incidents



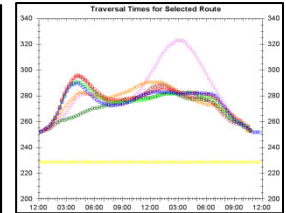
Unplanned Incidents



Planned Incidents



Traffic Patterns



~ 28 Million GPS Reports Per Day

NOKIA
Connecting People

Over 10 Million Phones Sold Annually in U.S.

Over 400 Million Phones Sold Annually Worldwide

Well positioned for Probe Expansion

~ 11,100 Total Sensor Miles

~ 3,200 Proprietary Miles

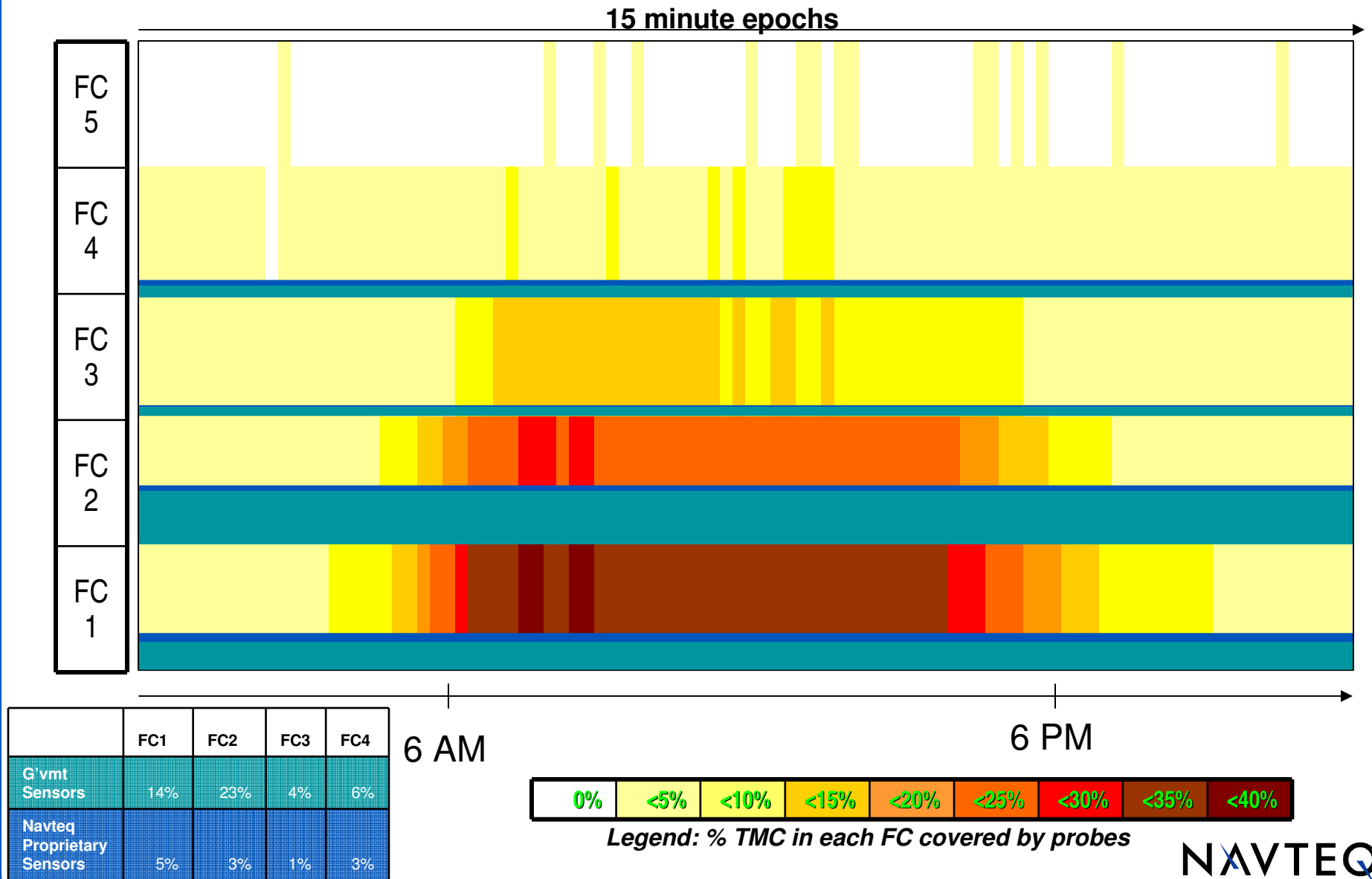
~ 500 Traffic Producers, 24x7 Coverage



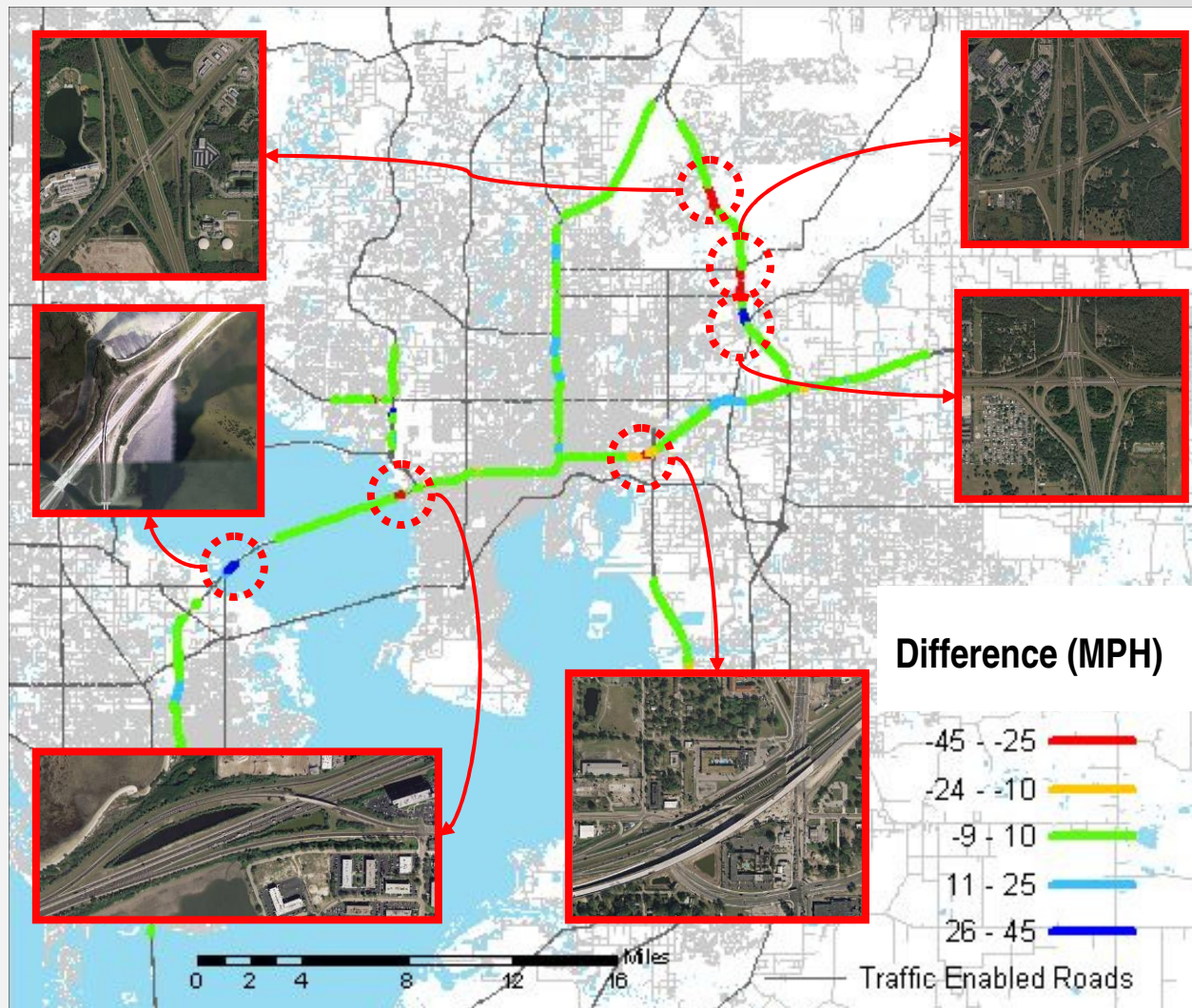
~ 910,000 Miles
Each Day of Week
Every 15 minutes
Holiday Appendix

NAVTEQ

However, commercial GPS probe data is not enough on its own

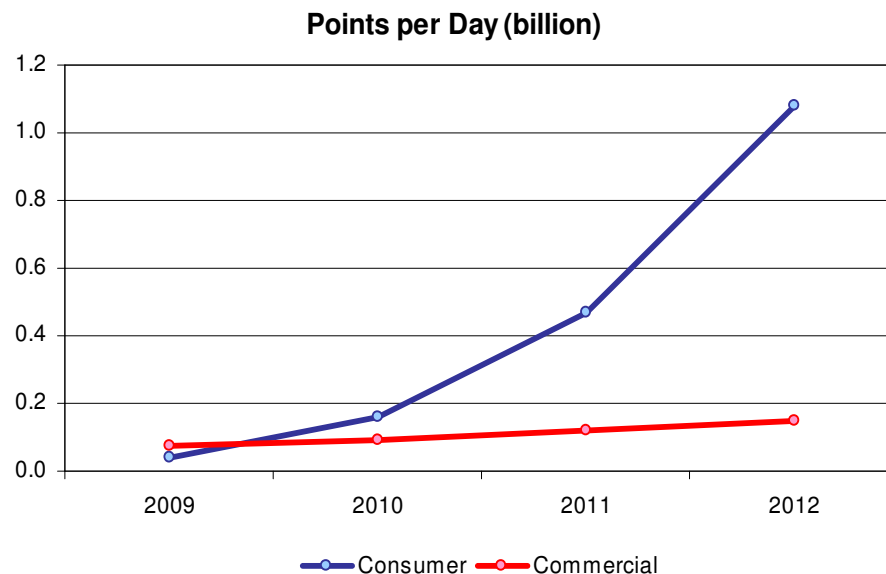
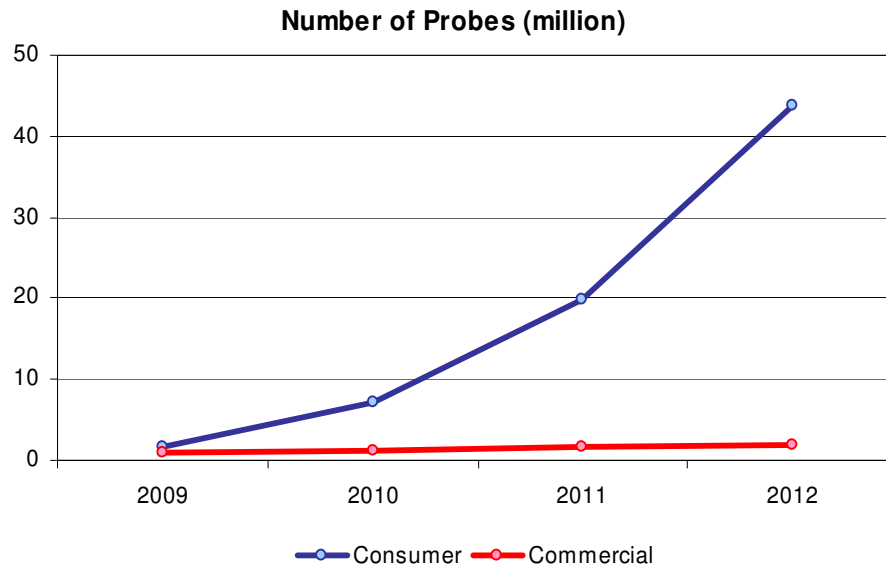


Cell network technology shows promise but issues remain



- Complex interchanges (both in dense urban road networks and in sparse networks) interfered with ability to infer true traffic conditions.
- Challenge was not limited to congestion detection. For example, a slow exit at the end of a bridge to an arterial led to false congestion reports on a freely moving highway that continued from the bridge (which itself was easy, not surprisingly).

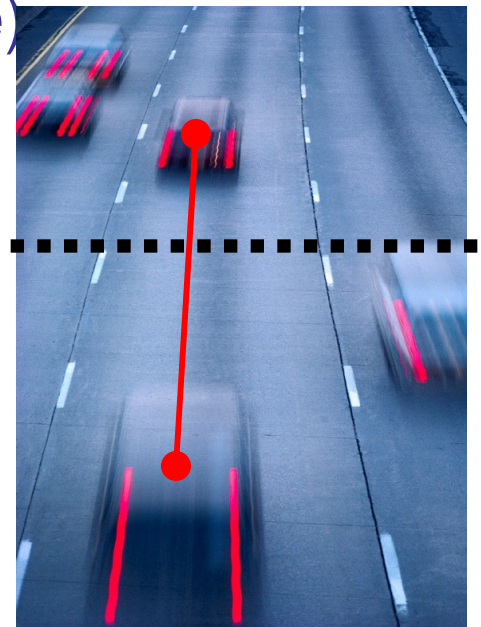
Fortunately, consumer GPS data will dwarf commercial data



- NAVTEQ and Partners are working hard to address:
 - **Privacy Issues**
 - **Business models**
 - Assess and justify the additional “network load” for carriers
 - Technical solutions are under development for “probe collectors”
 - Effect on reliability of mobile navigation applications
 - Efficiency/effectiveness of data extraction
 - Scale of data collection
- NAVTEQ is uniquely positioned to source consumer probe data
 - Tier 1 to many OEMs
 - Nokia relationship
 - Map and traffic products

Virtual Trip Lines for Probe Data Collection

- Virtual lines at intelligently placed locations
(placed for usefulness and privacy preservation)
 - Phone/device uses GPS to detect crossing of trip lines
 - Anonymously reports crossing with speed & travel time
(reports are probabilistic & skewed in time)
- Benefits
 - **Very efficient and Good privacy**
 - **No infrastructure required**
 - **Dynamic in space and time**



Privacy by Design

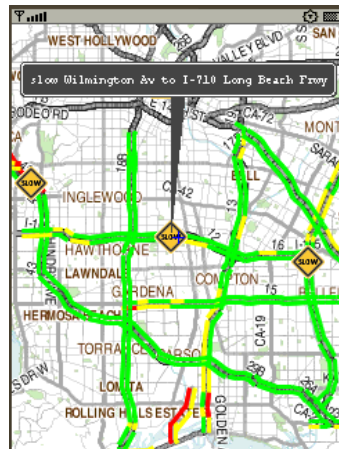
- Build Privacy into the system from the start
- Minimize the amount of sensitive information that is collected, transmitted and stored
- Discard unnecessary or revealing information at every step

Traffic Data Processing

- Navteq is extending their processing engine
 - In Collaboration with Nokia Research
 - To handle new consumer GPS probe data feeds
 - Integrated with all other data feeds
 - Proven quality and robustness
- UC Berkeley working with NRC
 - Developing next generation traffic processing algorithms
 - Specifically designed around consumer GPS probe data
 - Both highway and arterial road models
 - Both real-time and predictive support

Traffic Service Back to Users

- Users benefit from highest-quality, real-time traffic
 - Delivered to their cell phone (or connected nav device)
 - Developing innovative visualization of traffic data
 - Audio reports tailored to the user



February 8th Field Trial (Mobile Century)

- UC Berkeley / CCIT / Nokia Collaboration
 - Funded by Caltrans and Nokia
- 100 cars, 160 drivers, 8 hours, 20 miles of road
 - Carrying connected mobile device (Nokia N95 phone)
- Giving a glimpse into the future
 - 2-5% penetration of vehicles on the road
 - Real-time data collection, processing and reporting



The Mobile Millennium Pilot

- Large scale public pilot starting late 2008
 - Jointly run by California Center for Innovative Transportation (CCIT) and Nokia
 - In collaboration with UC Berkeley, Caltrans and Navteq
 - Other partners in discussion to help with distribution
 - Leveraging the prevalence of GPS-enabled cell phones
- Goals
 - To drive the refinement of the technologies
 - Prove the robustness, quality & usefulness of the service
 - Evaluate the quality and usefulness of the data

